

Evolutionary Acquisition (EA) Spiral Development (SD) Systems Engineering Methodology

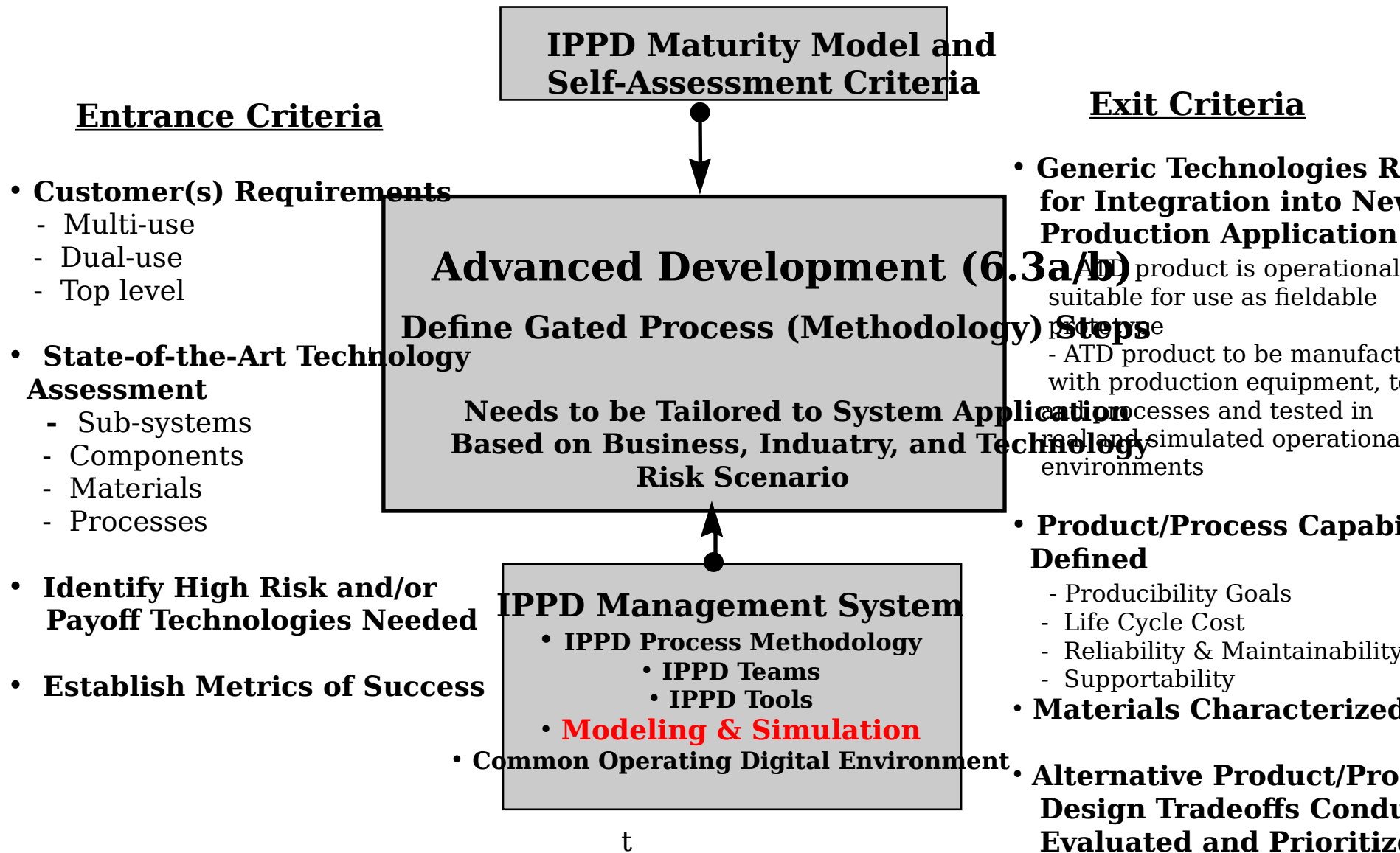
NDIA SED Conference

20 October 2003

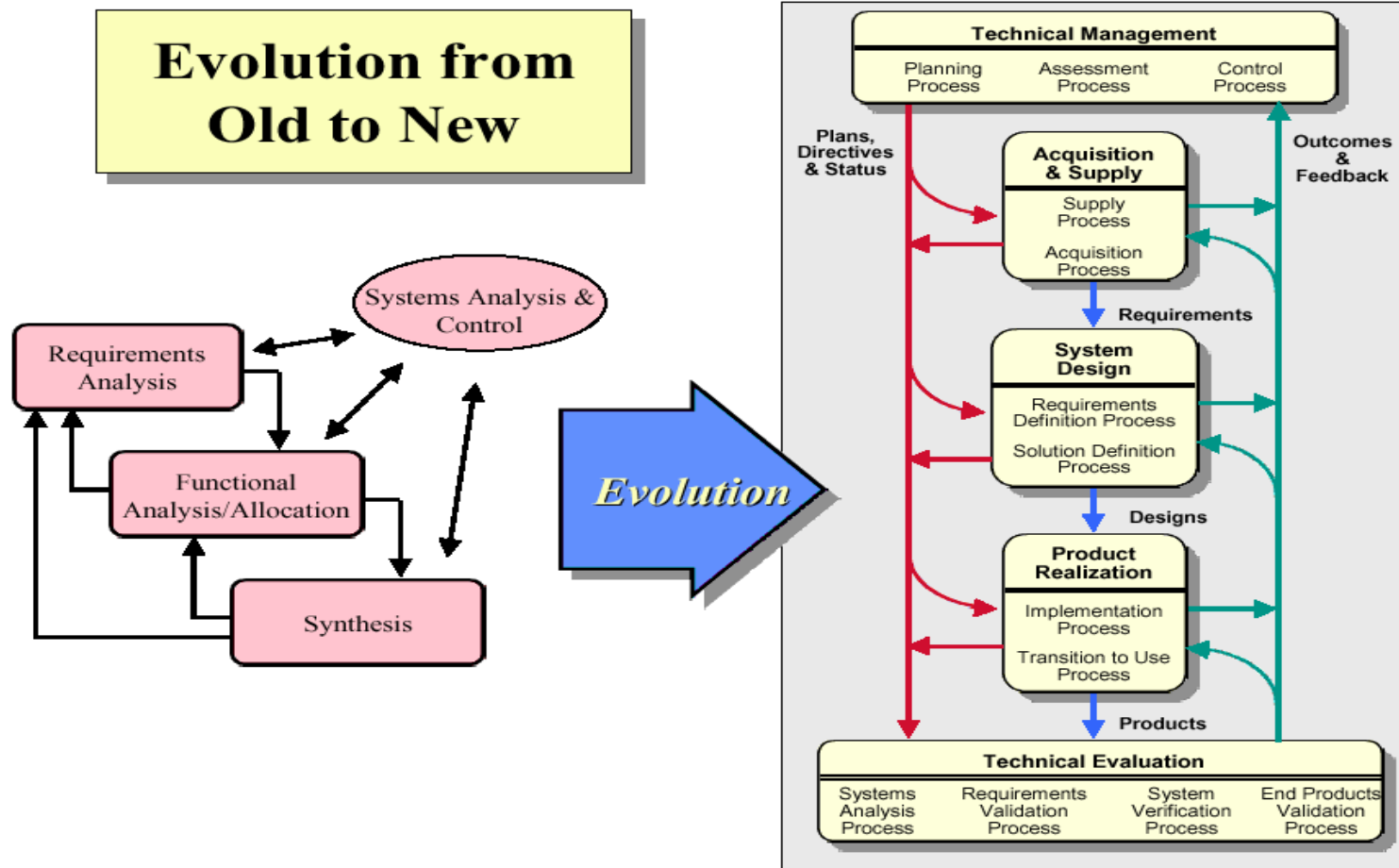
Richard (Dick) Engwall

RLEngwall & Associates

Industry Recommended DoD IPPD P

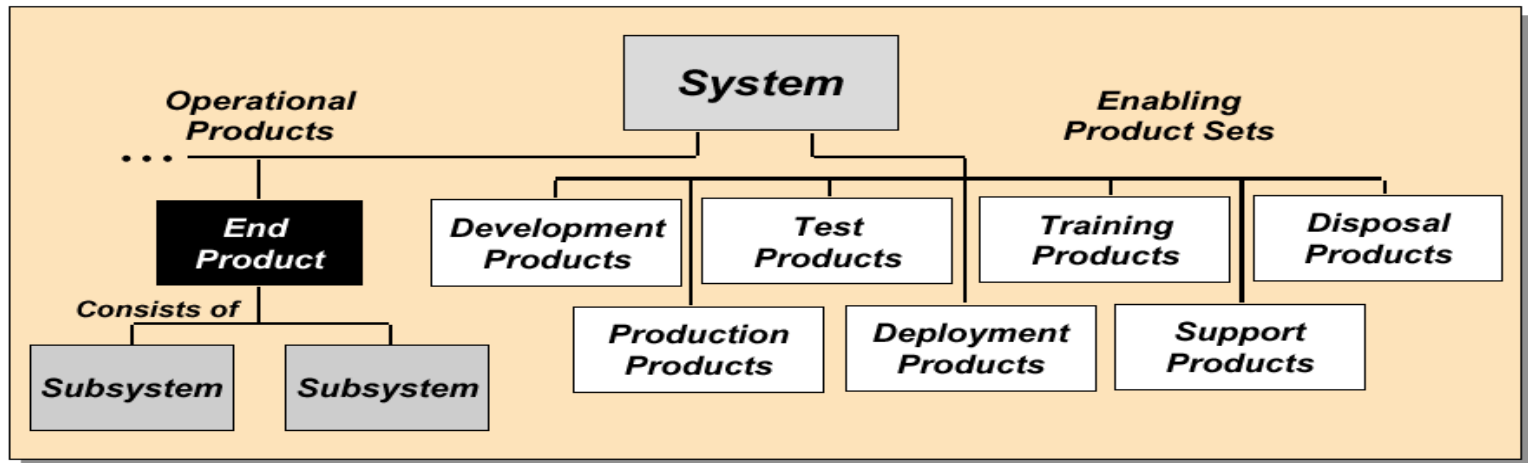


Evolution of MIL STD 499B to ANSI/EIA 632



The Systems Engineering Building Block Concept

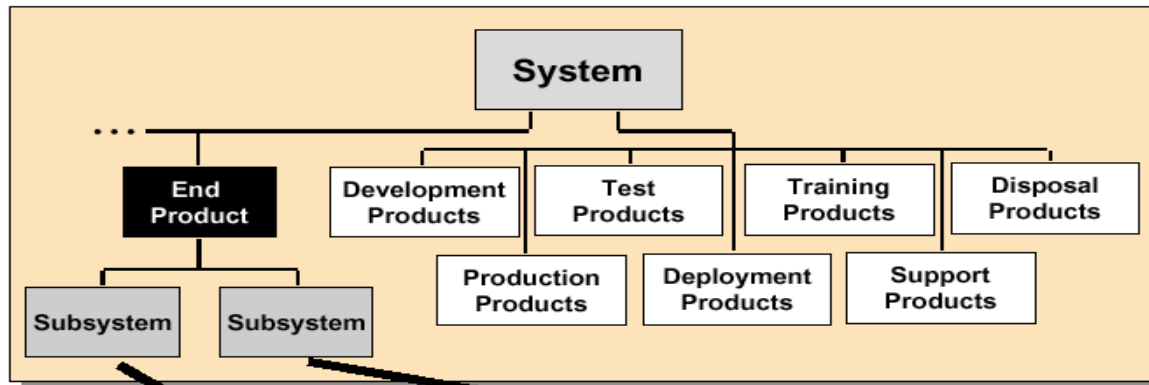
The Building Block Concept



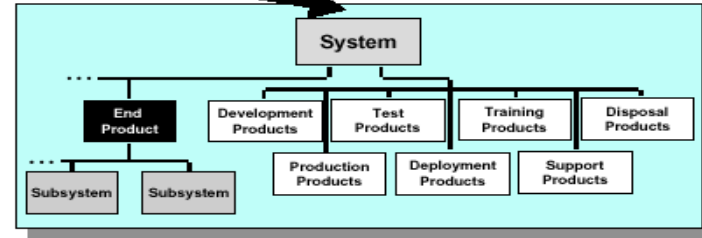
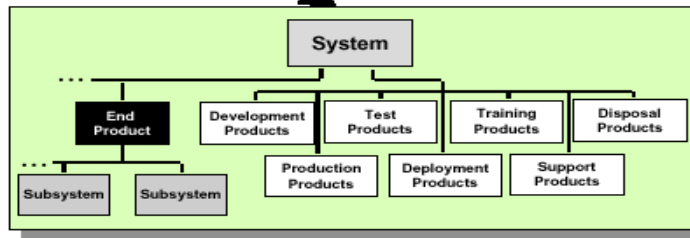
The System Engineering Development Building Block Layers Concept

Development Layers Concept

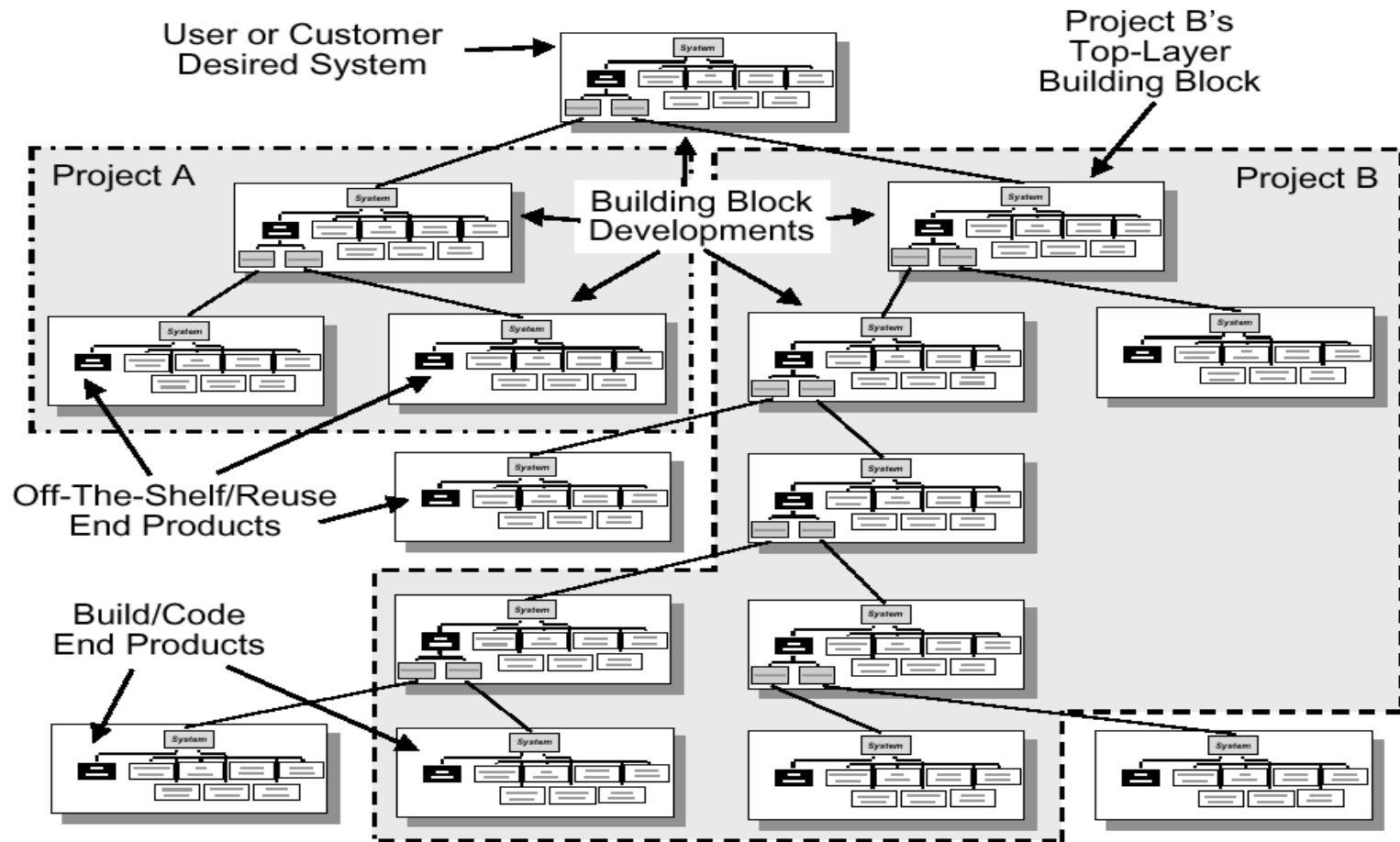
Layer N Building Block



Layer N+1 Building Blocks



Sample Layered Development System Structure



ANSI/EIA-632

Process Requirements for Engineering a System

SUPPLY PROCESS REQUIREMENTS 1—Product Supply ACQUISITION PROCESS REQUIREMENTS 2—Product Acquisition 3—Supplier Performance PLANNING PROCESS REQUIREMENTS 4—Process Implementation Strategy 5—Technical Effort Definition 6—Schedule and Organization 7—Technical Plans 8—Work Directives ASSESSMENT PROCESS REQUIREMENTS 9—Progress Against Plans and Schedules 10—Progress Against Requirements 11—Technical Reviews CONTROL PROCESS REQUIREMENTS 12—Outcomes Management 13—Information Dissemination	REQUIREMENTS DEFINITION PROCESS REQUIREMENTS 14—Acquirer Requirements 15—Other Stakeholder Requirements 16—System Technical Requirements SOLUTION DEFINITION PROCESS REQUIREMENTS 17—Logical Solution Representations 18—Physical Solution Representations 19—Specified Requirements IMPLEMENTATION PROCESS REQUIREMENTS 20—Implementation TRANSITION TO USE PROCESS REQUIREMENTS 21—Transition to Use SYSTEMS ANALYSIS PROCESS REQUIREMENTS 22—Effectiveness Analysis 23—Tradeoff Analysis 24—Risk Analysis	REQUIREMENTS VALIDATION PROCESS REQUIREMENTS 25—Statements Validation 26—Acquirer Requirements Validation 27—Other Stakeholder Requirements Validation 28—System Technical Requirements Validation 29—Logical Solution Representations Validation SYSTEM VERIFICATION PROCESS REQUIREMENTS 30—Design Solution Verification 31—End Product Verification 32—Enabling Product Readiness END PRODUCTS VALIDATION PROCESS REQUIREMENTS 33—End Products Validation
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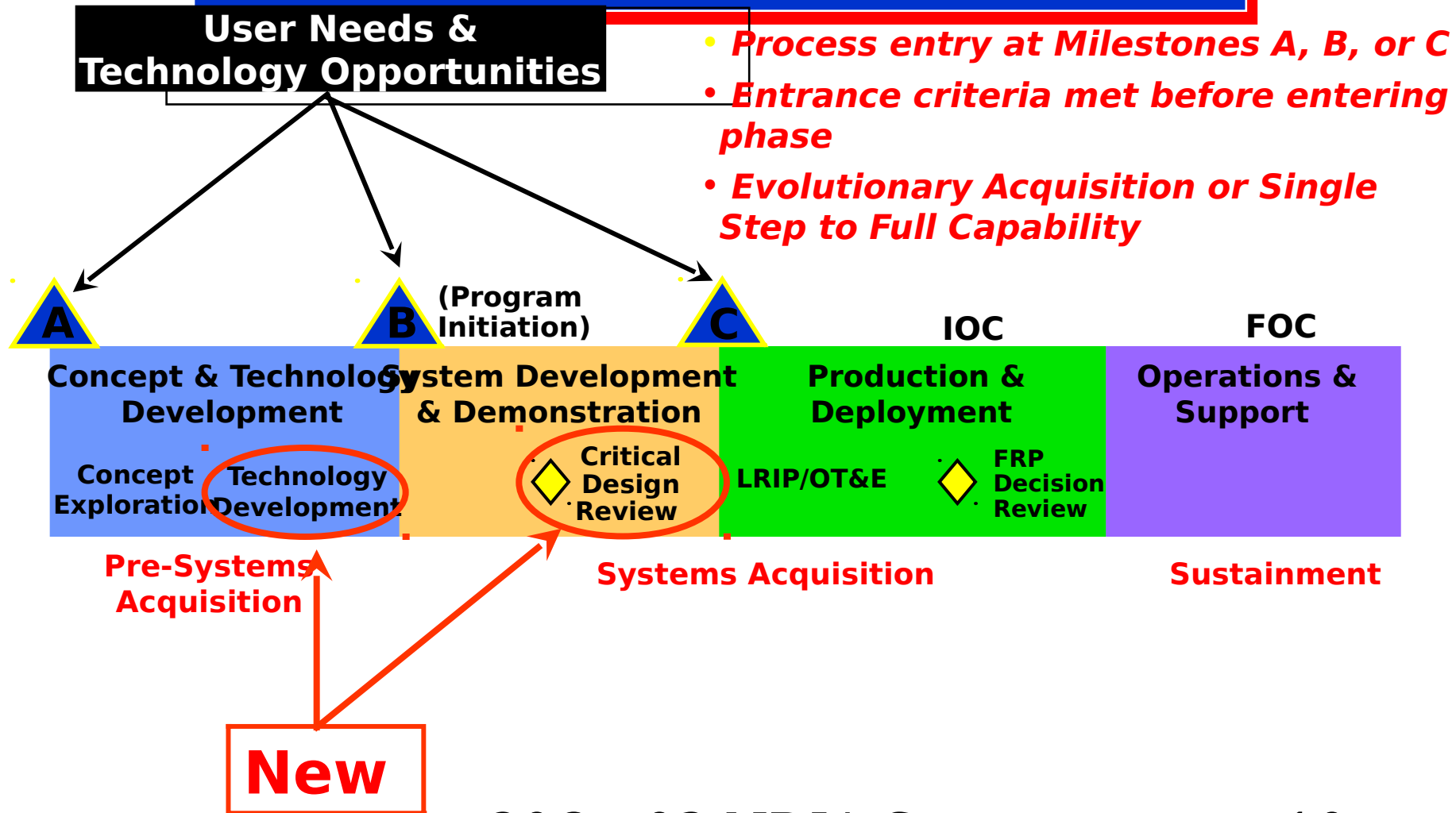
Application Guidelines of ANSI/EIA-632 (What not How Oriented)

- **Decide Which of the 33 Processes Apply**
- **Decide Which Requirements Apply for the Processes Selected**
- **Establish Appropriate Policies & Procedures**
- **Define Appropriate Tasks for Each of the Selected Requirements**

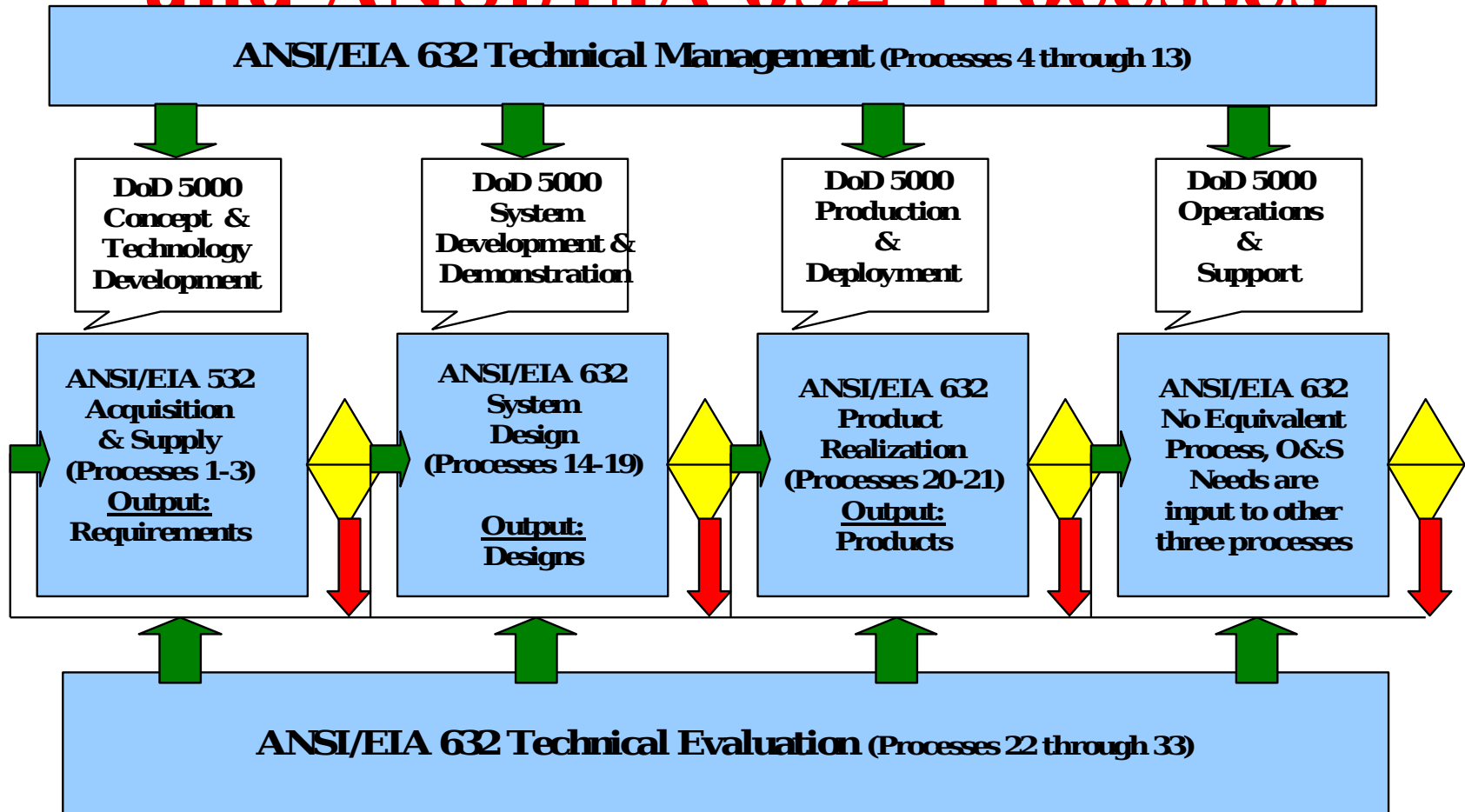
Application Guidelines of ANSI/EIA-632 (What not How Oriented) Continued

- **Establish Methods and Tools to Support Task Implementation**
 - **Representative Tasks Along With Their Expected Outcomes Are Provided in Annex C**
- **Appropriate Processes Are Applied Recursively and Iteratively**
- **Many Associate Tasks Are Concurrent And Highly Iterative And Have Interactive Dependencies That Lead To Alteration Of Previously Established Technical Requirements**

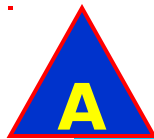
The 'Newer' 5000 MODEL



Interdependency of DoD 5000 and ANSI/EIA 632 Processes



Concept & Technology Development Phase



Concept
Exploration

Technology
Development

Concept

Exploration

Enter: Validated & approved ICD

- **Activity: Paper studies of alternative solutions to the initial concept**

Exit: MDA selects preferred solution to be pursued

Technology Development

Enter: Project leader understands solution as part of the integrated architecture and its DOTMLPF implications.

- **Activity: Technology development demonstrations**

Exit: Affordable increment of military-useful capability identified and demonstrated in relevant environment - normally can be developed for production within 5 years

System Development & Demonstration

B

Phase

System
Integrati
on

System
Demonstrati
on



Critical
Design
Review

System Integration

Enter: PM has technical solution but has not integrated subsystems into complete system

- **Activities: System Integration of demonstrated subsystems and components. Reduction of integration risk.**

Exit: Demonstration of prototypes in relevant environment

System

Demonstration

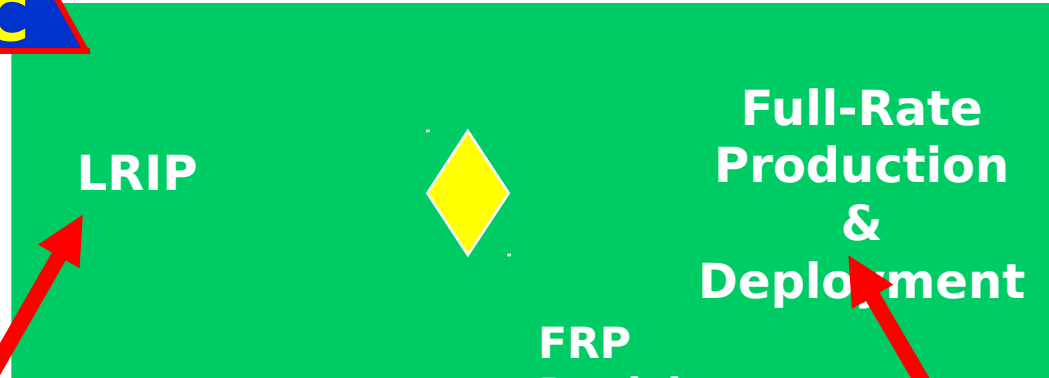
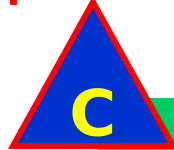
Enter: Prototypes demonstrated in intended environment

- **Activities: Complete development. DT/OT/LFT&E**

Exit: System demonstration in intended environment using engineering development models; meets validated requirements

Production & Deployment

Phase



LRIP

Full-Rate Production & Deployment

Enter: System matured for production

- **Activities:** Low-rate initial production. IOT&E, LFT&E of production-representative articles. Establish full manufacturing capability.

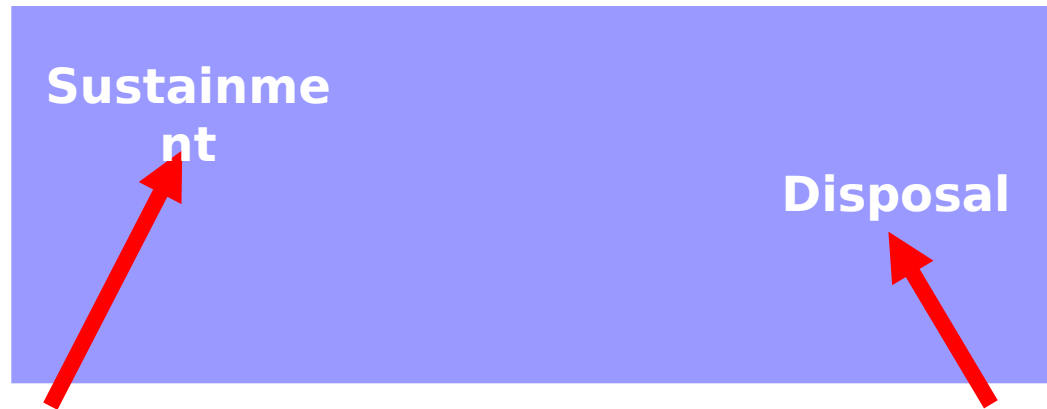
Exit: System operationally effective, suitable and ready for full rate production

Enter: Beyond LRIP (ACAT I) and LFT&E reports (covered systems) submitted to Congress

- **Activities:** Full rate production. Deploy system. Start support.

Exit: Full operational capability; deployment

Operations & Support Phase



Sustainme

Sustainment starts immediately upon fielding or deployment.

- **Activities:** Maintain readiness and operational capability of deployed system(s). Execute operational support plans. Conduct modifications and upgrades to hardware and software. Measure customer confidence.

Disposal

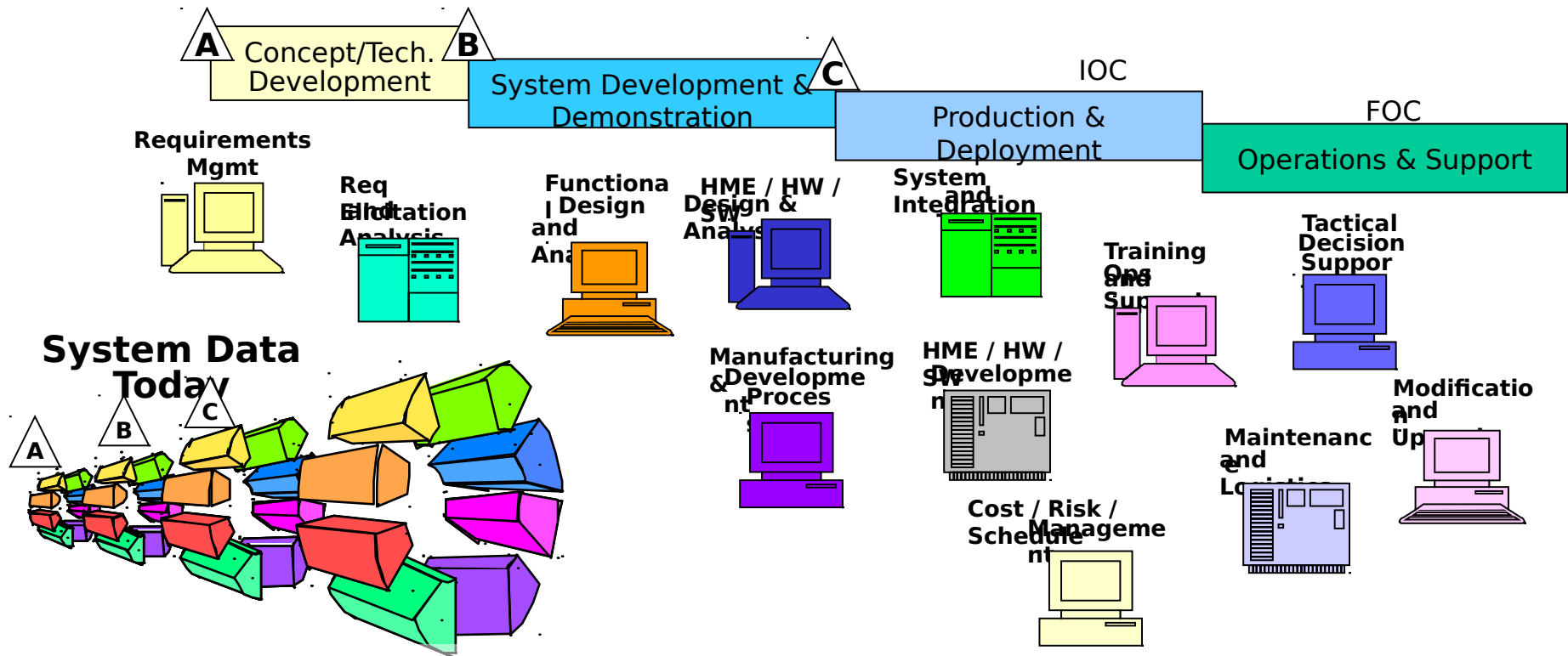
Demilitarization & Disposal

- **Activities:** Demilitarize and dispose of systems IAW legal and regulatory requirements, particularly environmental considerations. Use Defense Reutilization and Marketing Office support, as appropriate.

EA/SD System Engineering Impact on Information Systems

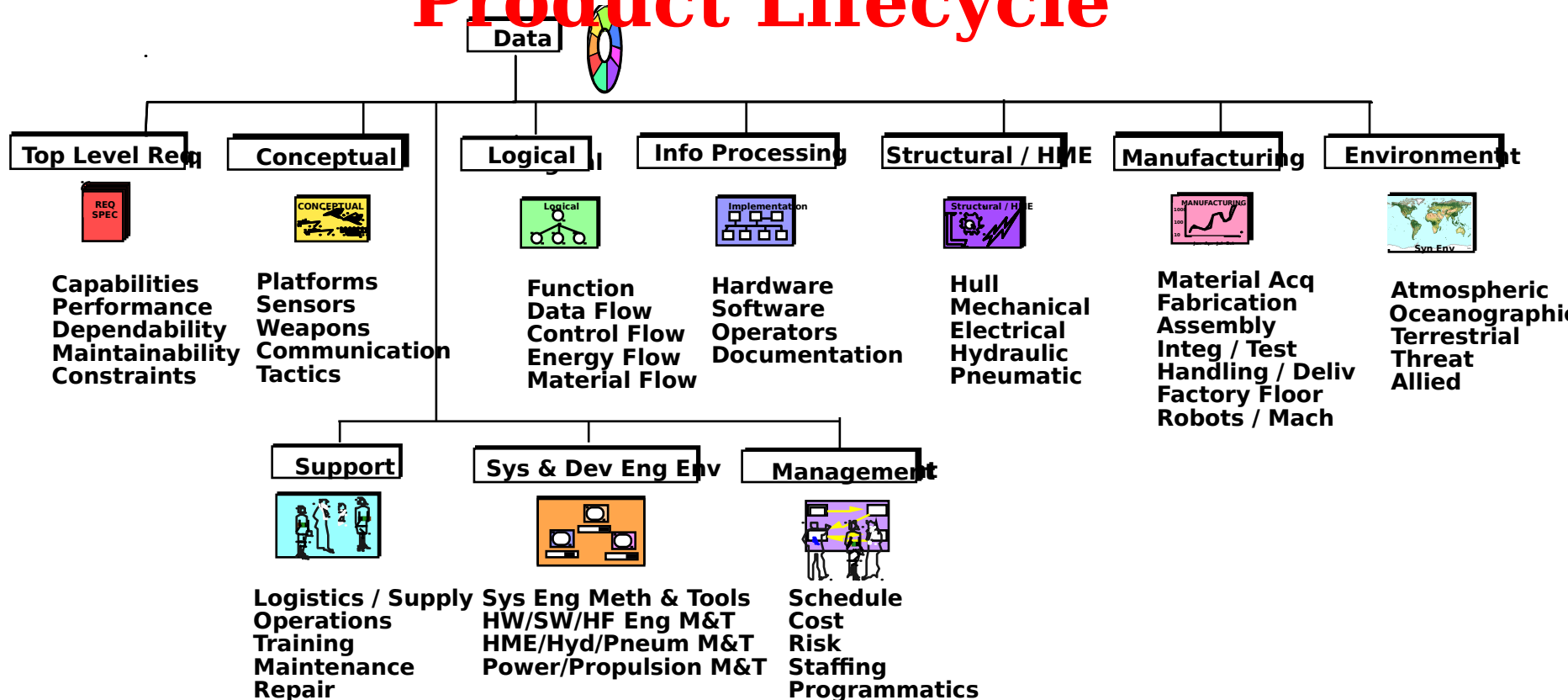
- **Need to Capture System Information Once in Common Interoperable Format**
- **Apply Distributed Tools for Collaborative Assessment & Optimization Including Pervasive Modeling & Simulation Throughout the System Engineering Product Life Cycle**
- **Utilize ANSI/EIA-632 Technical Management and Technical Evaluation Processes Throughout the DoD Acquisition Process**
- **A Broad, Extensible Representation Approach Is Key**
 - **Use EIA-927 Common Data Schema For Complex Systems**

The Complex Systems Tower of Babel



- Stovepiped Tools With Limited Scope and No Substantial Interoperability
- Multiple Independent Files and Databases With Ad Hoc Manual Configuration Management, Traceability, and Consistency Checking across Domains
- Most PDM and Enterprise Management Solutions are *File* Based and Fail to Provide any Useful Integration of the *Information* Stored in the Files

Common Data and Systems Across the Product Lifecycle



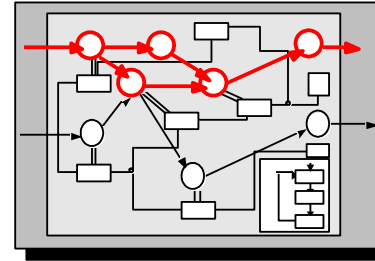
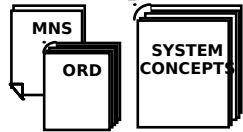
- A Formal Structure for Representing Spectrum of System Data is needed
- A Dynamic Schema Provides Means for Accommodating Emerging Data Representation Needs
- A broad, extensible representation approach is key

SBA Concept

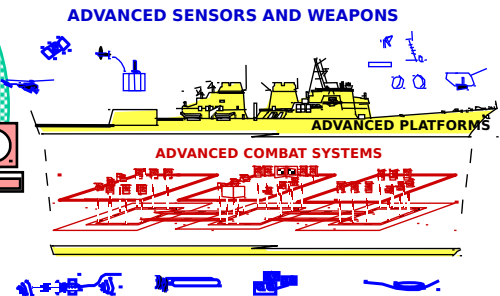
Conceptual Development

Functional Design

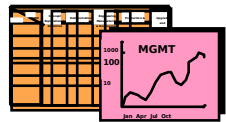
Top Level System Requirements



Physical & Info System (HW/SW) Design



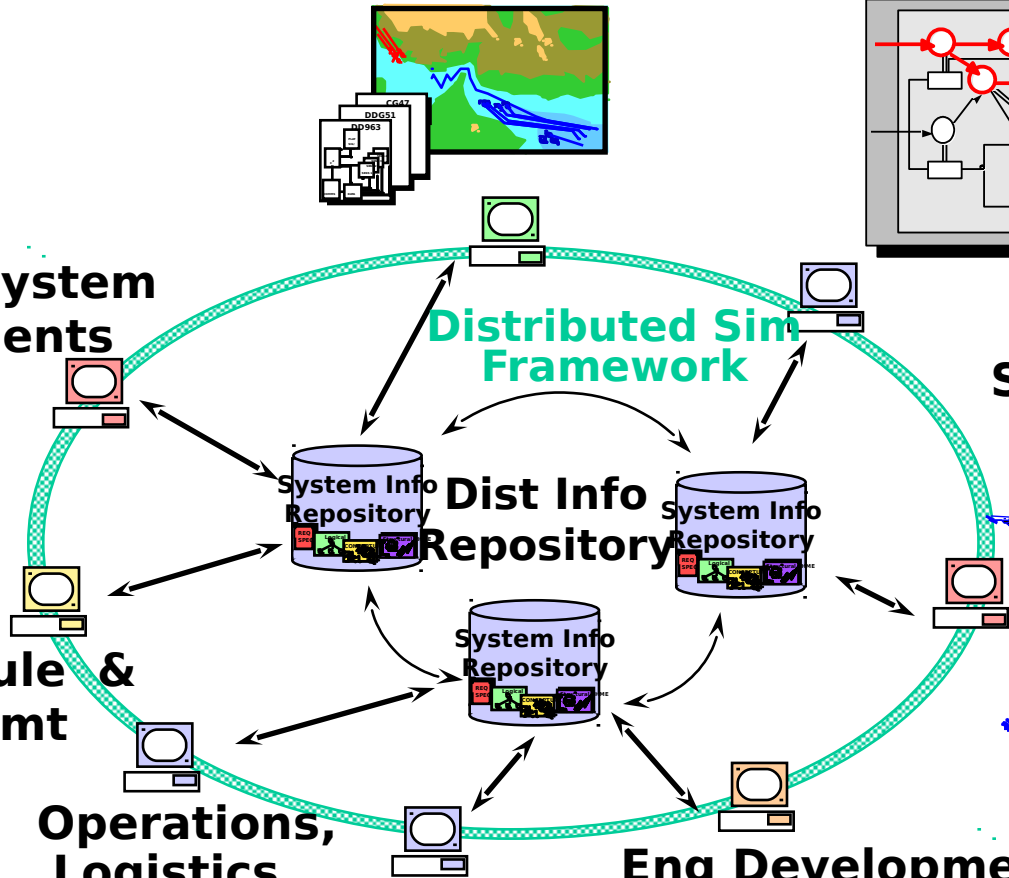
Cost, Schedule & Program Mgmt



Operations, Logistics & Training



Test & Eval & Manufacturing



SF Product Development Information Model (top-level)

Coherency & completeness cross-checks

- Solid lines = primary
- Dashed lines = secondary

Government provided context information

Operational Context
(scenarios, etc.)

Blue systems

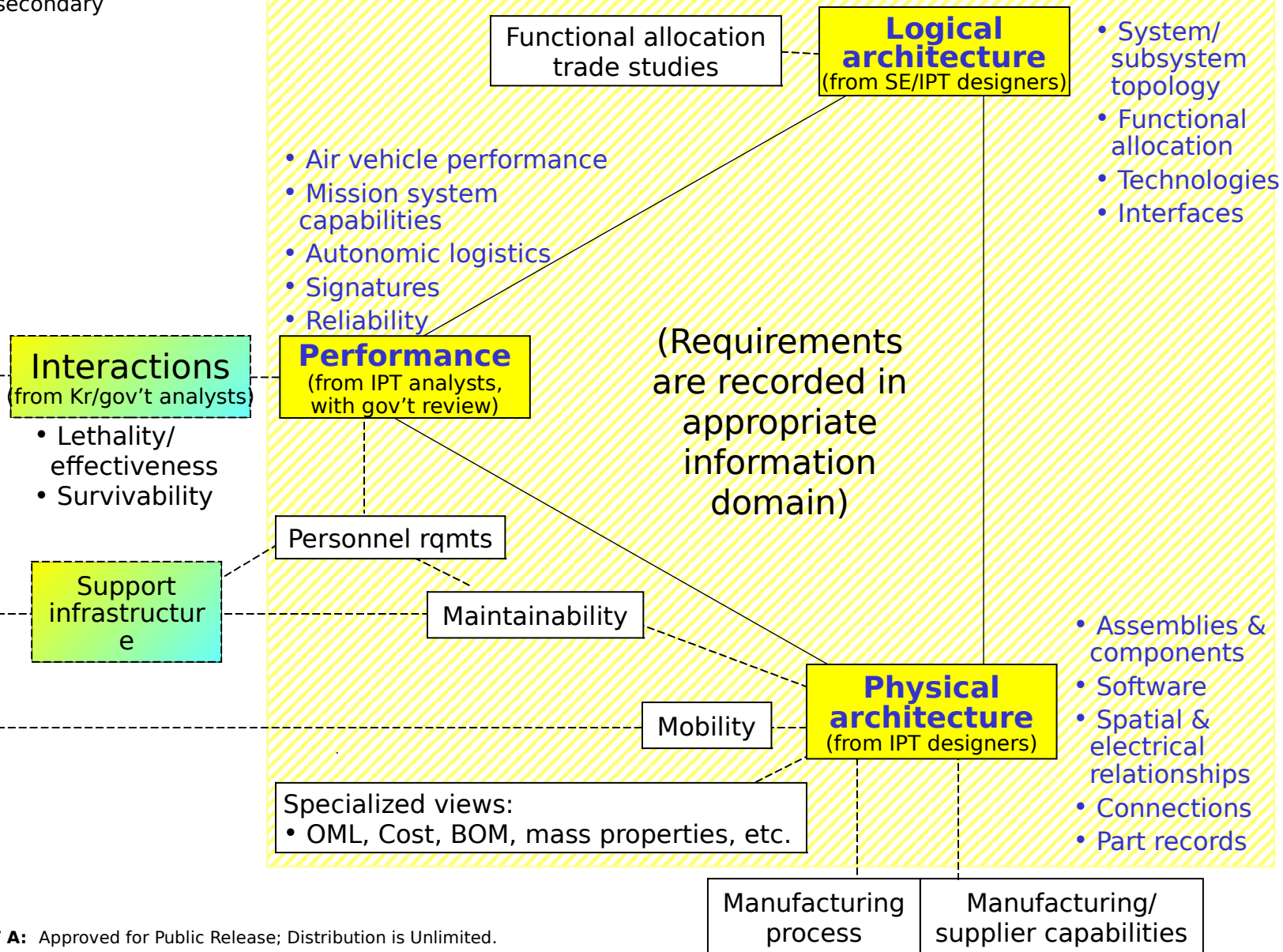
Threat systems

Natural environment

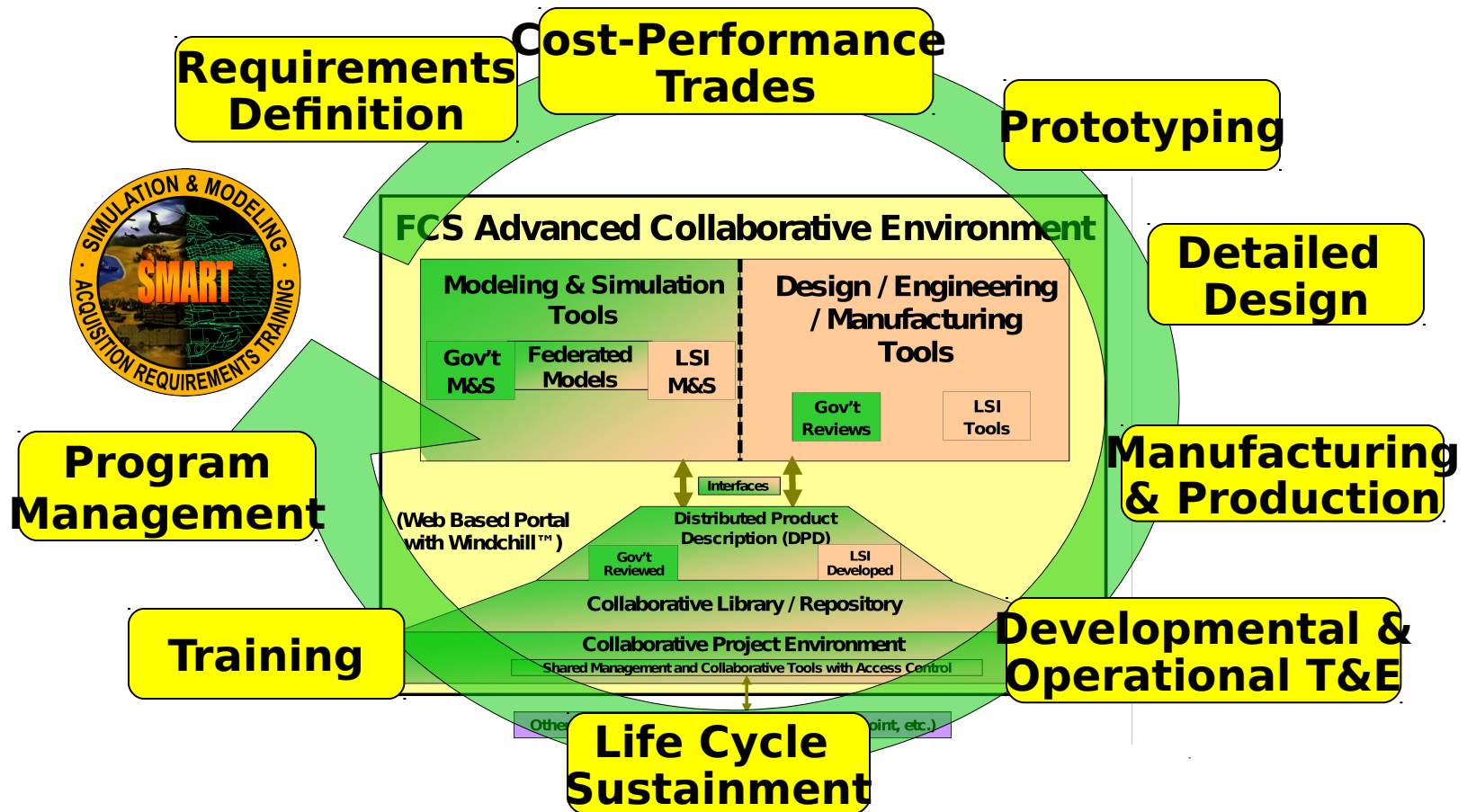
Civil/military infrastructure

Transportation capabilities

LM Aero provided Product Information Model (DPD) (Variants = layered instance values)

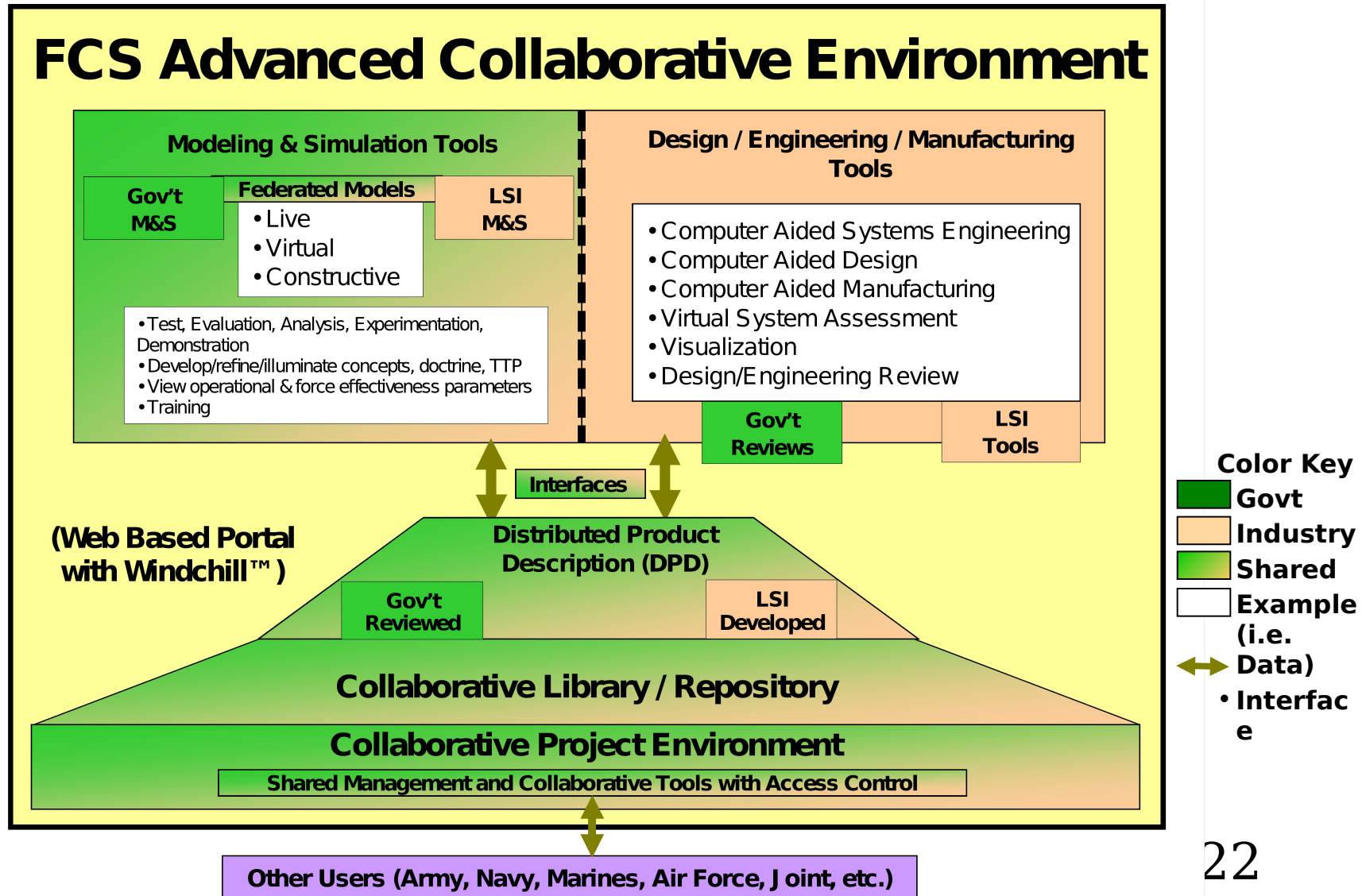


FCS ACE Enables SMART



Field FCS-Equipped Units of Action With Threshold Objective Force Capability by the End of the Decade.

FCS ACE Diagram



Questions?

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